



## ***PCM Compression***

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# Session B2: General Interest Topics for T&E Professionals

Session Chair: Mr. Tim Laffoon

## PCM Compression

Shannon Wigent & Dr. Andrea Mazzario

17<sup>th</sup> Test Instrumentation Workshop  
Wednesday, 21 May 2014

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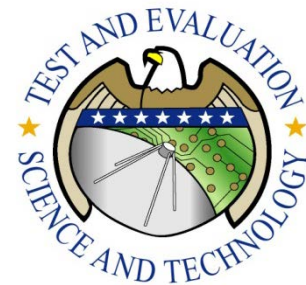
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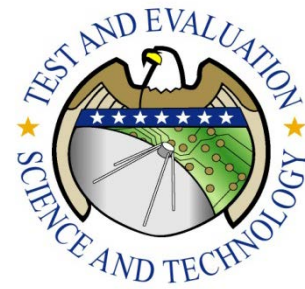
# Outline



- Introduction
- Project Background
- Smart Data Selection Overview & Results
- Introduction of PCM Compression in SDS Framework
- Benefits to T&E



# Project Background



- Smart Data Selection (SDS) initially awarded as a T&E S&T project in 2013
- The objective of SDS was to identify solutions to address the following T&E gaps:
  - The need for enhanced spectrum efficiency to the support level of data being generated on the test article
  - The need to enhance operator awareness during a test event
  - The need to simplify pre-test Test Article setup



# SDS Description

*“The dominant inherent nature to TM in DoD testing is sampled time-history data from an ultimately analog world, (which) is not going to change drastically regardless of how data is transmitted to ground. A factor that could change that fact most is the degree to which answers instead of data are obtained on board the test vehicle”*

iNET Concept of Operations, v. 2007.1

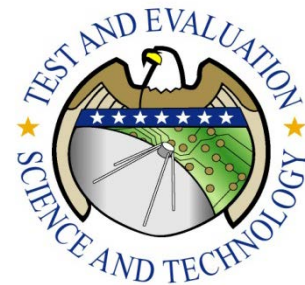
- SDS seeks to change this inherent nature of telemetry in DoD testing by:

- Developing an on-board capability to monitor and analyze test data in order to reduce the amount of data sent to the ground
- Employing bandwidth efficient algorithms to reduce bandwidth requirements
- Developing the capability to notify operators when data demonstrate abnormal behavior

**Results in Significant Savings in Spectrum and Increased Operator Awareness**



# SDS ConOps



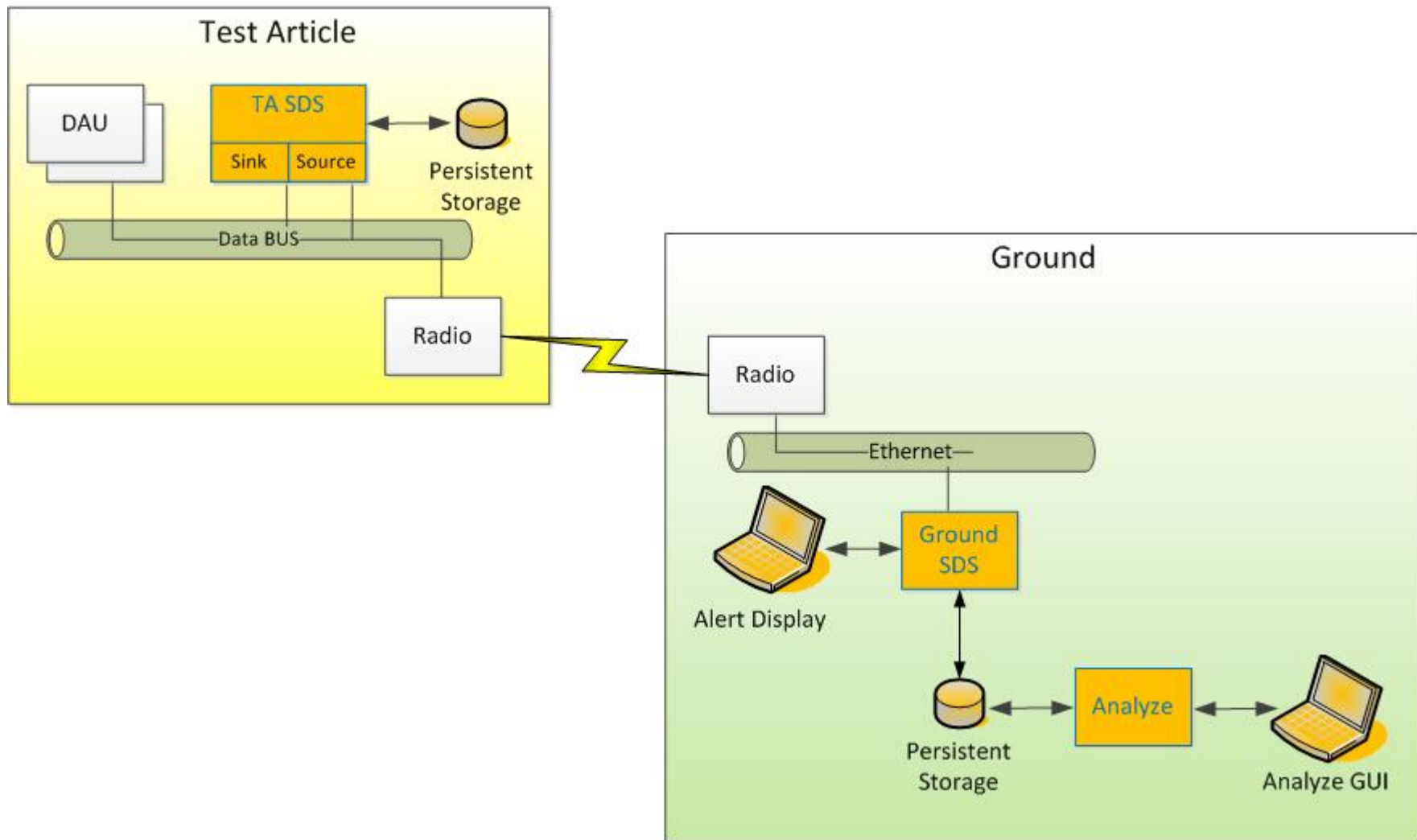
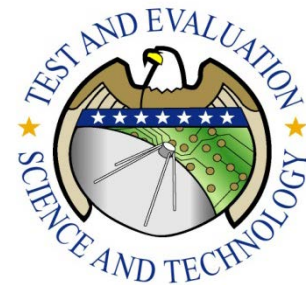
## The SDS system:

- Analyzes pre-recorded data to identify behavioral trends
- Applies user-defined behavioral criteria
- Subscribes to all on-board parameters
- Determines what live data is of interest for real-time observation and analysis
- Applies bandwidth efficient algorithms to selected measurements
- Generates specific messages to be sent to ground
- Provides alerts for data that demonstrate abnormal behavior
- Supports user feedback in response to alerts



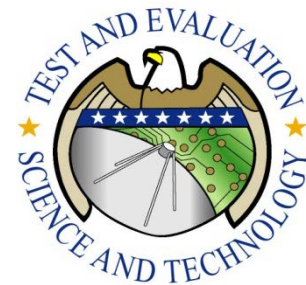


# System Description





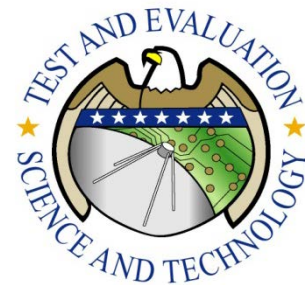
# Bandwidth Efficient Algorithms



- SDS applies extrapolation algorithms to “Normal” data
  - Allows for TA transmission of extrapolation parameters rather than individual measurement values
  - Ground calculates and publishes with required frequency
- TA monitors error between extrapolation values and actual measurements
- If error threshold exceeded, new extrapolation parameters are calculated and transmitted to the ground



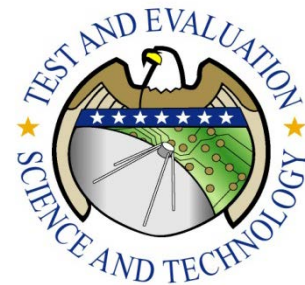
# Bandwidth Savings



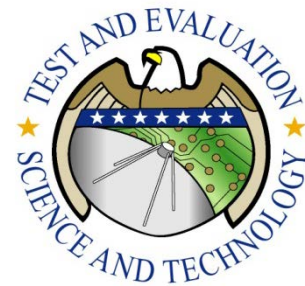
- Representative test results:
  - ~45,000 measurements at 98.04 Hz
- **Very small error threshold:**
  - Error  $\leq 0.01\%$
  - SDS requires less than 7% of original bandwidth
- **Small error threshold:**
  - Error  $\leq 0.02\%$
  - SDS requires less than 3% of original bandwidth



# Introduction of PCM Compression



- Utilize existing SDS framework to apply compression to PCM
- Provide a compression solution with minimal alterations to existing PCM telemetry systems
- Provide PCM compression within TmNS messages
- Apply *lossless* data compression algorithms in conjunction with error correction for significant bandwidth savings

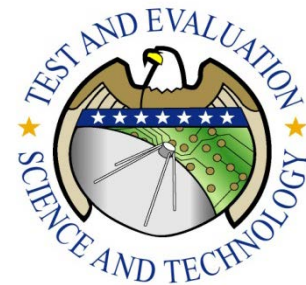


# Benefits of Compression

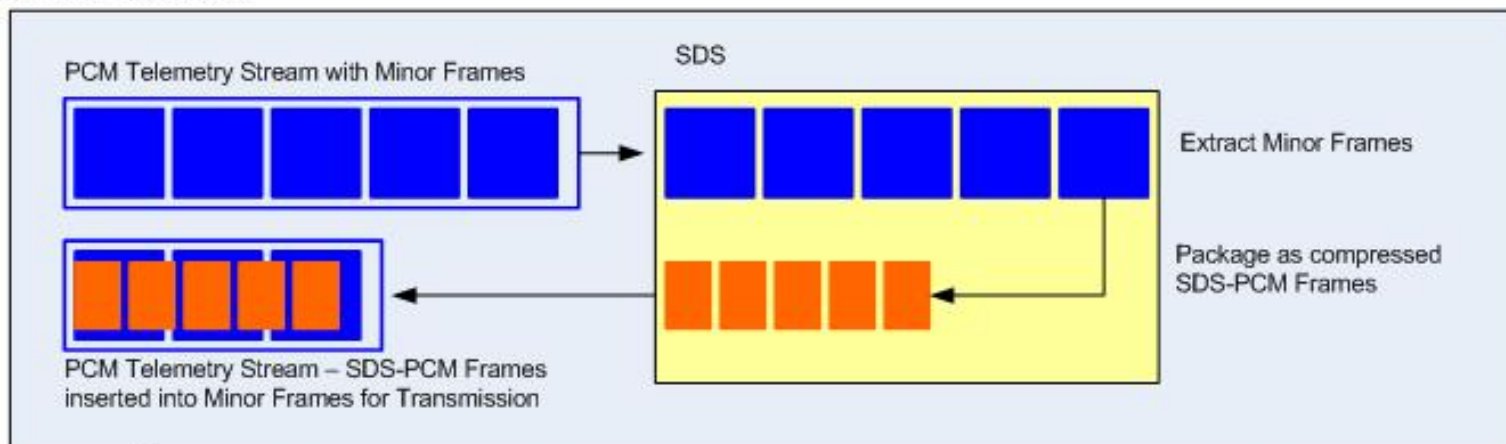
- Potential to yield a 70% increase in bandwidth utilization
  - Provides availability to great volume of test data
  - Provides ability to support increased number of test articles concurrently
  - 70% increase observed in earlier prototypes utilizing lossless compression. Potential exists for even greater than 70%.
- Utilization of telemetry data characteristics improves upon compression rates resulting from standard lossless compression algorithms



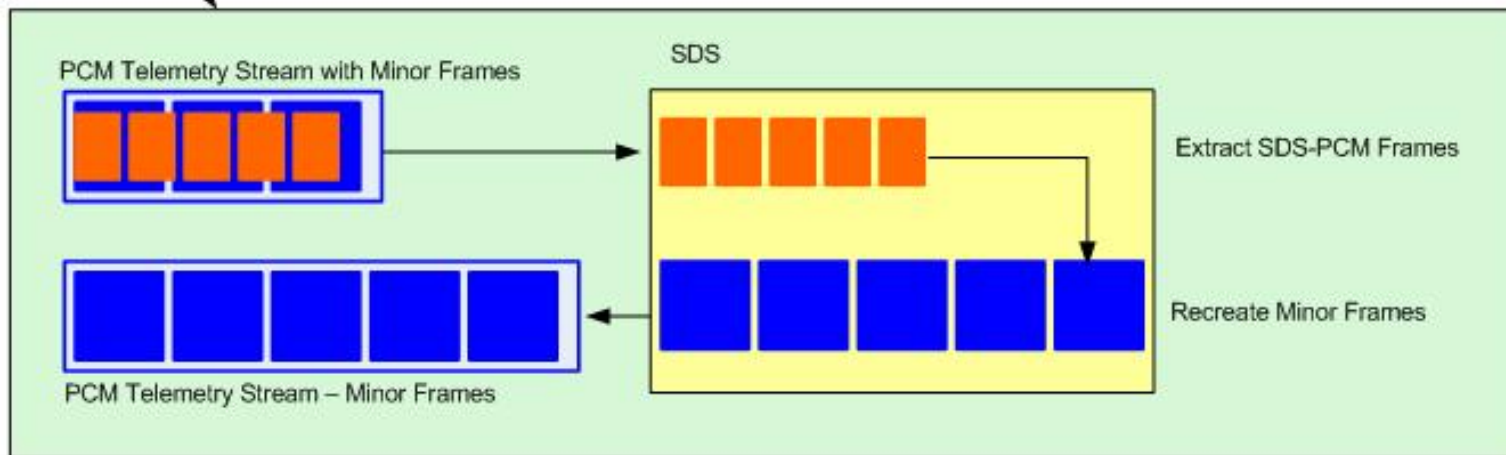
# Introduction of PCM Compression



On-Board Test Article



Ground-Based





# PCM Enhancement

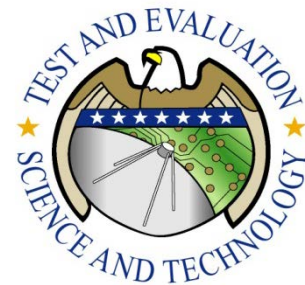


- SDS current implementation is based on TmNS message format
  - Test Article and Ground modules to be updated to process PCM minor frames embedded in TmNS messages
- New capability to be added to process PCM in traditional PCM environment



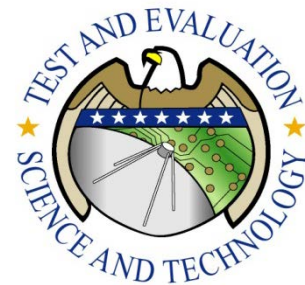


# Benefits to T&E



- Bandwidth Savings/Increased Spectrum Efficiency
- Enhanced Operator Awareness of Test Conditions





# QUESTIONS?